CLAIM AMENDMENTS

1 - 26 (cancelled)

27. (currently amended) A method for the scheduling of a service resource shared among several information packet flows that generate respective associated queues, said flows including synchronous flows (i ~~= 1, 2, .., N_S~~) that require a guaranteed minimum service rate (r_i) and asynchronous flows (j ~~= 1, 2, ...,~~ ~~N_R~~) that use the service capacity of [[said]] the resource that is left unused by the synchronous flows, method making use of a server and comprising the following steps:

(a) causing said server to visit the respective queues associated to said flows (i, j) in successive cycles on the basis of a target rotation time value (TTRT), which identifies the time necessary for the server to complete a visit cycle on said respective queues;

(b) associating each synchronous flow (i) with a respective synchronous capacity value (Hi) indicating a maximum period of time for which the respective synchronous flow can be serviced before the server moves on;

(c) associating each asynchronous flow (j) with a first respective delay value (Li) that identifies a value that must be made up for the respective queue to have the right to be serviced, and a second respective value (*last_visit_time*) that indicates an instant in which the server visited the respective queue in a

previous cycle, determining for said respective queue, a time that has elapsed since the server's previous visit;

(d) servicing each queue associated to a synchronous flow (i) for a maximum service time relative to said respective value of synchronous capacity (H_i);

(e) servicing each queue associated to an asynchronous flow (j) only if the server's visit occurs before the expected instant, said advance being determined as the difference between said target rotation time value (TTRT) and time that has elapsed since the server's previous visit and the accumulated delay; if positive, this difference defining a maximum service time for each asynchronous queue; and

(f) defining said respective synchronous capacity value (H_i) for the queue associated to the i-th synchronous flow by insuring that:

(f_1) a sum of the synchronous capacity values for said synchronous flows plus the duration of the longest packet services by said shared service resource (T_{max}) does not exceed said target rotation time value (TTRT); and

(f_2) said target rotation time value (TTRT)is not lower than a ratio of said longest packet serviced by said shared service resource (T_{max}) to a complement to one of the sum over said synchronous flows of the minimum service rates (r_i)required by said synchronous flows normalized to the service capacity (C) of said shared service resource.

28. (previously presented) The method defined in claim 27 which includes the step of defining said respective synchronous capacity value (H_i) for the queue associated to the i-th synchronous flow as the product of the minimum service rate required by said i-th synchronous flow (r_i) and said target rotation time value (TTRT) normalized to the service capacity of said shared service resource (C).

29. (previously presented) The method defined in claim 27 which includes the step of defining said respective synchronous capacity value (H_i) for the queue associated to the i-th synchronous flow by:

defining a factor (α) such that the sum over said synchronous flows of the minimum service rates (r_i) required by said synchronous flows normalized to the service capacity (C) of said shared service resource is not larger than the complement to one of said factor (α); and

defining said respective synchronous capacity value (H_i) for the queue associated to the i-th synchronous flow as said target rotation time value (TTRT) times the ratio of a first and a second parameter, wherein:

said first parameter is the sum of the number of said asynchronous flows (N_A)and said factor (α), said sum times the minimum service rates (r_i) required by said synchronous flows

normalized to the service capacity (C) of said shared service resource, and

said second parameter is the sum of the number of said asynchronous flows (N_A) plus the complement to one of the sum over said synchronous flows of the minimum service rates (r_i) required by said synchronous flows normalized to the service capacity (C) of said shared service resource.

30. (previously presented) The method defined in claim 27 which includes the step of insuring that the sum over said synchronous flows of the minimum service rates (r_i) required by said synchronous flows normalized to the service capacity (C) of said shared service resource does not exceed unity.

31. (previously presented) The method defined in claim 27 wherein said respective synchronous capacity value (H_i) for the queue associated to the i-th synchronous flow is defined by satisfying:

i) the expressions

$$\sum_{i=1}^{N_S} H_i + \tau_{\max} \leq TTRT$$

$$TTRT \geq \frac{\tau_{\max}}{1 - \sum_{h=1}^{N_S} r_h / C}$$

ii) as well as the last one of the following expressions

$$H_i = \frac{r_i \cdot TTRT}{C} \quad \text{and} \quad H_i = \frac{(N_A + \alpha) \cdot r_i / C}{N_A + 1 - \sum_{h=1}^{N_S} r_h / C} \cdot TTRT$$

where:

H_i is said respective synchronous capacity value (H_i) for the queue associated to the i-th synchronous flow,

the summations are extended to all the synchronous flows, equal to N_s,

N_A is the number of said asynchronous flows,

T_{max} is the duration of the longest packet service by said shared service resource,

TTRT is said target rotation time value,

C is the service capacity of said shared service resource,

r_i is the minimum service rate required by the i-th synchronous flow, with $\sum_{h=1}^{N_S} r_h / C < 1$, and

α is a parameter that gives $\sum_{h=1}^{N_S} r_h / C \le 1 - \alpha$

32. (currently amended) The device defined in claim 27 wherein during each of said successive cycles, said server performs a double scan on all the queues associated to said synchronous flows (i ~~= 1, 2, ..., N_s~~) and then visits the queues associated to said asynchronous flows (j ~~= 1, 2 ..., N_A~~).

33. (previously presented) The device defined in claim 32 which includes the following steps:

associating with each synchronous flow (i) a further value (Δ_i) indicating the amount of service time that is available to the respective flow,

during a major cycle of said double scan servicing each queue associated to a synchronous flow (i) for a period of time equal to the maximum said further value (Δ_i), and

during a minor cycle of said double scan servicing only one packet of each queue associated to a synchronous flow (i), provided that said further value (Δ_i) is strictly positive.

34. (previously presented) The device defined in claim 33 which includes the step of incrementing said further value (Δ_i) by said respective value of the synchronous capacity (H_i) when the queue is visited during the major cycle of said double scan.

35. (previously presented) The device defined in claim 33 which includes the operation of decrementing said further value (Δ_i) of the transmission time by each packet serviced.

36. (previously presented) The device defined in claim 33 wherein the servicing of each queue associated to a synchronous flow (i) during the major cycle of said double scan ends when one of the following conditions occurs:

the queue is empty,

the time available, represented by said further value (Δ_i), is not sufficient to service the packet at the front of the queue.

37. (previously presented) The device defined in claim 36 which includes the operation of resetting said further value (Δ_i) when the respective queue is empty.

38. (previously presented) The device defined in claim 33 which includes the step of decrementing the service time of said further value (Δ_i) in the presence of a service given during the minor cycle of said double scan.

39. (previously presented) The device defined in claim 33 wherein during said double scan of all the queues associated to said synchronous flows (I), said minor cycle ends when one of the following conditions is satisfied:

the last queue associated to a synchronous flow (i) has been visited,

a period of time not less than the sum of the capacities (H_i) of all of the queues associated to said synchronous flows (i) has elapsed since the beginning of said major cycle of said double scan.

40. (previously presented) The device defined in claim 33 which includes the step of initializing said further value (Δ_i) to zero.

41. (previously presented) The device defined in claim 27 wherein in the case that said difference is negative, each said queue associated to an asynchronous flow (j) is not serviced and the value of said difference is accumulated with said delay (L_j).

42. (previously presented) The device defined in claim 27 wherein the service of a queue associated to an asynchronous flow (j) ends when one of the following conditions is satisfied:

the queue is empty,

the time available is not sufficient to transmit the packet that is at the front of the queue.

43. (previously presented) The device defined in claim 27 wherein said first respective value (L_j) and said second respective value (last_visit_time) are respectively initialized to zero and to a moment of startup of the current cycle when the flow is activated.

44. (currently amended) A system for the scheduling of a service resource shared among several information packet flows that generate respective associated queues, said flows including synchronous flows (i ~~= 1, 2, ..., N_s~~) that require a guaranteed

minimum service rate and asynchronous flows (j ~~= 1, 2, ..., N_R~~) destined to use the service capacity of said resource left unused by the synchronous flows, the system including a server able to visit the respective queues associated to said flows (i, j) in successive cycles, which is configured to perform the following operations:

determine a target rotation time value (TTRT) that identifies the time necessary for the server to complete a visiting cycle of said respective queues,

associate to each synchronous flow (i) a respective synchronous capacity value (Hi) indicating the maximum amount of time for which a synchronous flow can be serviced before moving on to the next,

associate to each asynchronous flow (j) a first respective delay value (L_j) that identifies the delay that must be made up for the respective queue to have the right to be serviced, and a second respective value (last_visit_time) that indicates the instant in which in the previous cycle the server visited the respective queue, determining for said respective queue, the time that has elapsed since the server's previous visit,

service each queue associated to a synchronous flow (i) for a maximum period of time relating to said respective synchronous capacity value (H_i), and

service each queue associated to an asynchronous flow (j) only if the server's visit occurs before the expected instant, said advance being determined as the difference between said target

rotation time (TTRT) and the time that has elapsed since the server's (10) previous visit and the accumulated delay difference, if positive, defining the maximum service time for each said asynchronous queue,

the system being configured to define said respective synchronous capacity value (H_i) for the queue associated to the i-th synchronous flow by ensuring that:

the sum of the synchronous capacity values for said synchronous flows plus the duration of the longest packet serviced by said shared service resource (T) does not exceed said target rotation time value (TTRT); and

said target rotation time value (TTRT) is not lower than the ratio of said longest packet serviced by said shared service resource (Tmm) to the complementary to one of the sum over said synchronous flows of the minimum service rates (ri) required by said synchronous flows normalized to the service capacity (C of said shared service resource.

45. (previously presented) The system defined in claim 44 which is configured for defining said respective synchronous capacity value (H_i) for the queue associated to the i-th synchronous flow as the product of the minimum service rate required by said i-th synchronous flow (r_i) and said target rotation time value (TTRT) normalized to the service capacity of said shared service resource (C).

46. (previously presented) The system defined in claim 44 which is configured for defining said respective synchronous capacity value (Hi) for the queue associated to the i-th synchronous flow by:

defining a factor (a) such that the sum over said synchronous flows of the minimum service rates (ri) required by said synchronous flows normalized to the service capacity (C) of said shared service resource is not larger than the complementary to one of said factor (a);

defining said respective synchronous capacity value (Hi) for the queue associated to the i-th synchronous flow as said target rotation time value (TTRT) times the ratio of a 30said first and a second parameter, wherein:

said first parameter is the sum of the number of said asynchronous flows (N_A) and said factor (α), said sum times the minimum service rates (ri) required by said synchronous flows normalized to the service capacity (C) of said shared service resource, and

said second parameter is the sum of the number of said asynchronous flows (N_A) plus the complementary to one of the sum over said synchronous flows of the minimum service rates (ri) required by said synchronous flows normalized to the service capacity (C) of said shared service resource.

47. (previously presented) The system defined in claim 44 which is configured for ensuring that the sum over said synchronous

flows of the minimum service rates (ri) required by said synchronous flows normalized to the service capacity (C) of said shared service resource does not exceed unity.

48. (previously presented) The system defined in claim 44 which is configured to define said respective synchronous capacity value (H_i) for the queue associated to the i-th synchronous flow by ensuring that the following are satisfied:

i) the expressions

$$\sum_{i=1}^{N_s} H_i + \tau_{\max} \leq TTRT$$

$$TTRT \geq \frac{\tau_{\max}}{1-\sum_{h=1}^{N_s} r_h/C}$$

i) as well as at least one of the following expressions

$$H_i = \frac{r_i \cdot TTRT}{C}$$ and

$$H_i = \frac{(N_A + \alpha) \cdot r_i / C}{N_A + 1 - \sum_{h=1}^{N_S} r_h / C} \cdot TTRT$$

where:

H_i is the said respective synchronous capacity value (H_i) for the queue associated to the i-th synchronous flow,

the summations are extended to all the synchronous flows, equal to N_s,

N_A is the number of said asynchronous flows,

T_{max} is the service duration of the longest packet by said shared service resource,

TTRT is said target rotation time value,

C is the service capacity of said shared service resource,

r_i is the minimum service rate requested by the i-th synchronous flow, with $\sum_{h=1}^{N_S} r_h / C < 1$, and

α is a parameter that gives

$$\sum_{h=1}^{N_S} r_h / C \le 1 - \alpha$$

49. (previously presented) The system defined in claim 44 wherein, during each of the said successive cycles, said server (10) performs a double scan on all the queues associated to said synchronous flow ($i = 1, 2, ..., N_S$) and then visits the queues associated to said asynchronous flows ($j = 1, 2, ..., N_A$).

50. (previously presented) The system defined in claim 44 wherein:

a further value (Δ_i), indicating the amount of service time available to the respective flow, is associated to each synchronous flow (i),

during a major cycle of said double scan, each queue associated to a synchronous flow (i) is serviced for a period of time equal to the maximum further value (Δ_i) , and

during a minor cycle of said double scan the system services only one packet of each queue associated to a synchronized flow (i), provided said further value (Δ_i) is strictly positive.

51. (previously presented) The system defined in claim 50 wherein said further value (Δ_i) is incremented by said respective synchronous capacity value (H_i) when the queue is visited during the major double scan cycle.

52. (previously presented) The system defined in claim 50 wherein said further value (Δ_i) is decremented by the transmission time of each packet serviced.

53. (previously presented) The system defined in claim 50 which is configured so that the service of each queue associated to a synchronous flow (i) during the major cycle of said double scan ends when one of the following conditions occurs:

the queue is empty,

the time available, represented by said further value (Δ_i), is not sufficient to serve the packet at the front of the queue.

54. (previously presented) The system defined in claim 53 wherein said further value (Δ_i) is reset when the respective queue is empty.

55. (previously presented) The system defined in claim 50 wherein in the presence of a service given during the minor cycle of said double scan, said further value (Δ_i) is decremented by the amount of service time.

56. (previously presented) The system defined in claim 50 wherein during said double scan on all the queues associated to said synchronous flows (i), said minor cycle ends when one of the following conditions is satisfied:

the last queue associated to a synchronous flow (i) has been visited,

a period of time not less than the sum of the capacities (Hi) of all of the queues associated to said synchronous flows (i) has elapsed since the beginning of said major cycle of said double scan.

57. (previously presented) The system defined in claim 50 wherein said further value (Δ_i)is initialized to zero.

58. (previously presented) The system defined in claim 50 wherein, if said difference is negative, each said queue associated to an asynchronous flow (j) is not serviced and the value of said difference is accumulated with said delay (L_j).

59. (previously presented) The system defined in claim 50 wherein the service of a queue associated to an asynchronous flow (j) ends when one of the following conditions is satisfied:

the queue is empty,

the time available is not sufficient to transmit the packet that is at the front of the queue.

60. (previously presented) The system defined in claim 50 wherein said first respective value (L_j) and said second respective value (last_visit_time) are respectively initialized to zero and to the moment of startup of the current cycle when the flow is activated.